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Injuries in recreational curling include head injuries and may be prevented by using proper footwear

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Abstract

Introduction: Our study examines a recreational curling population to describe patterns of injury occurrence, estimate risk of injury and to gauge attitudes towards equipment-based prevention strategies.

Methods: In a retrospective case series, we queried the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), a national injury surveillance database, for curling injuries entered between 1993 and 2011. Kingston General Hospital and Hotel Dieu Hospital provide the two Kingston, Ontario, sites for emergency department (ED) care and participate in CHIRPP. Each retrieved entry underwent a chart review. A secondary survey was mailed to select individuals who had experienced curling injuries to solicit details on their injury and attitudes towards equipment to prevent injury. We used descriptive statistics for rates and proportions.

Results: Over 90% of acute curling injuries resulted from a fall, and 31.7% were head impacts. We found that acute injuries requiring ED presentation occur at a rate of approximately 0.17 per 1000 athlete-exposures (95% CI: 0.12–0.22). The secondary survey was completed by 54% of potential respondents. Of survey respondents, 41.3% attributed their fall to a lack of proper footwear and 73.5% of respondents agreed with mandatory sport-specific footwear as a prevention strategy, but only 8% agreed with mandatory helmet wear.

Conclusions: Although curling injuries requiring medical care are not common, head injuries make up a large proportion. Mandated use of appropriate footwear appears to be the most effective prevention strategy, as well as the measure deemed most acceptable by players.

Keywords: curling, athletic injury, brain concussion, injury prevention, emergency medicine

Key findings

- Curling is a popular sport in Canada yet patterns of injury in recreational curlers have not been described.
- Our study examined the mechanism and anatomical nature seen with injuries in recreational curlers who presented for care to an emergency department setting in Kingston, Ontario, that participates in the Canadian Hospitals Injury Reporting and Prevention Program.
- Over 90% of injuries were related to uncontrolled falls on ice with head injuries (including concussions) and upper limb fractures and contusions being lead anatomic patterns.
- A survey of injured curlers demonstrated strong support for use of appropriate footwear as a key preventive strategy, but not for helmet wear.

Introduction

Curling is a popular recreational and competitive sport and a fundamental part of Canadian identity.[1-3] Since the 1998 Winter Olympics, curling has been an official Olympic sport. Although the World Curling Federation comprises 49 member countries, Canadians make up about 80% of the worldwide curling population, with between 730 000 and 870 000 curlers.[1,2,4] Yet there is little published information on occurrence of injuries.

Curling is played on ice. The object of the game is to slide a 20-kilogram stone on an ice sheet so that it comes to rest as close as possible to a target. Two teams, each made up of four members, alternate strategic throwing of these rocks. Team members alter the course of the stone by using brushes to sweep and thus melt the ice around the stone to reduce friction.

There are many opportunities for injury when curling. While the slipperiness of the ice is exploited in the game, balance, flexibility and experience are required to minimize risk of falls. Sweeping is vigorous and requires co-ordination while sliding and avoiding obstacles.[5] Mastery of these techniques and skills can require years of dedicated practice.

Curling is generally perceived as a sport with a low risk for injury, though the published data are sparse and have concentrated on the competitive population. One study that focused on two national championships found that acute injuries resulting in "time loss," or athlete-exposures (AEs), occurred at a self-reported rate of 2 to 2.3 per 1000 games.[4] At another

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men's championship, acute injuries occurred at a self-reported rate of 3.5 per 1000 AEs.[6] At the 2010 Winter Olympics, the acute injury rate requiring medical attention was 2.5 per 1000 AEs; the two acute injuries happened to men while the women's bracket reported no injuries.[7] Most of the injuries reported were sprains to the knee, back and shoulder; none specifically reported head injuries.

Curling uses sport-specific equipment to maximize performance and minimize injury risk. Proper sporting equipment includes a brush for sweeping and for stabilization when "delivering the rock" and sport-specific curling shoes called "grippers" and "sliders." These shoes not only enhance curling performance, but also reduce the risk of slipping when moving on the curling sheet. Whereas brushes are used universally, curling clubs often do not enforce the use of proper footwear for the recreational curler. Some recreational curlers use running shoes instead of grippers, and tape the soles of their shoes to permit sliding instead of using a proper slider. Head protection is not traditionally used in curling.

Several key questions about curling injuries remain unanswered. All studies to date have focused on elite, competitive curlers, who represent a small proportion of all curlers, and almost certainly have a different injury profile than recreational curlers. These previous studies have also examined smaller populations of curlers (100 or fewer) and have collected information at a single point in time. Attitudes of curlers towards equipment-based prevention strategies also remain unknown, but are essential to effective sports injury prevention.[8]

The aims of our observational, descriptive study are three-fold: (1) to describe the type and severity of injuries among recreational curlers; (2) to approximate the rate of acute curling injuries in a recreational population over several years; and (3) to assess curlers' attitudes to using equipment to prevent injuries.

This research study was given ethics approval by the Health Sciences Research Ethics Board at Queen's University in Kingston, Ontario, Canada.

Methods

Location of study

Kingston is home to three curling clubs: the Royal Kingston, the Cataraqui and the Garrison Clubs. The Kingston community is served by two hospitals: Kingston General Hospital and Hotel Dieu Hospital. They are the only emergency departments (EDs) in Kingston, and each provides services to adults and children. Both have diagnostic radiology services and, unlike in many other Canadian cities, there were no walk-in clinics with X-ray services during the time of study.

Population at risk

The population at risk was estimated using membership counts of the three curling clubs in Kingston, which totaled 1184 in the year 2012 (Table 1). We assumed that the local membership counts were stable over the study period. Data were acquired through personal communication with membership administrators. Reports from Sport Canada show relatively stable national participation rates in curling in 1998 (1.3%),[9] 2005 (1.1%)[10] and 2010 (0.9%).[11] We also assumed that injured curlers who presented to the Kingston General Hospital or Hotel Dieu Hospital were from one of the Kingston curling clubs. Age groupings assessed were 0 to 17, 18 to 34, 35 to 49, 50 to 64 and 65 years and over.

TABLE 1
Membership count of Kingston curling clubs in 2012, by age and gender

Age, years	Male	Female	Total
0–17	83	36	119
18–34	53	27	80
35–49	70	65	135
50–64	259	246	505
≥ 65	218	127	345
Total	683	501	1184

CHIRPP database and chart review

The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is an ED-based injury surveillance database established in 1990.[12] There are 15 participating hospitals across Canada: 11 pediatric and 4 general. When injured patients present to the ED of a participating hospital, they are asked to complete a one-page questionnaire describing the circumstances and mechanism of injury and to provide demographic information. Research staff record details on the nature of the injuries and treatments. Both Kingston General Hospital and Hotel Dieu Hospital participate in CHIRPP.

We identified potential participants for our study using two strategies. First, a specific code in the CHIRPP database identifies curling as the activity leading to injury. Second, we performed a text search for "curl" in the injury description. We searched for injuries during an 18-year period between 1993-10-1 and 2011-02-28. We then reviewed each retrieved entry and removed irrelevant or duplicate entries. We tried to identify acute curling injuries and disregarded chronic injuries related to curling.

After identifying study participants, we reviewed patient medical records to obtain further information on how the injury happened, what part of the anatomy was injured, the severity of the injury and the treatment.

Secondary survey

We identified curlers who had had an injury in the most recent decade of data availability (ending 2011-02-28). We searched medical records to identify those known to have died and exclude them from the survey. We identified 104 eligible curlers to whom we mailed a paper survey alongside a description of the survey goals. The survey asked about mechanism and causation of injury, attitudes towards equipment-based injury prevention strategies, additional curling injuries and demographic characteristics. A reminder was mailed to non-responders six weeks later. There was no incentive for completing the survey.

TABLE 2
Curling experience of secondary survey respondents at time of injury

AEs per week, % (n = 49)		Years of curling experience, % (n = 48)	
<1 time	22	<1	17
1–2 times	39	1–3	17
3–4 times	35	4–6	13
>4 times	4	≥7	54

Abbreviation: AE, athlete-exposure.

Statistical analysis

Rate of injury was calculated by dividing the number of acute injuries by the number of AEs of the population at risk (Table 2). AEs were calculated by using the secondary survey data for games played per week and multiplied by length of the curling season. A curling season was counted as months that we captured more than 10 injuries. Statistical significance was assessed using chi-square tests. Rejection of the null hypothesis required $p < .05$.

Results

Acute injury rate

We identified 223 people with curling injuries. Of these, 208 were classified as acute rather than chronic injuries (Table 3). Six athletes had two independent curling injuries. The youngest curler injured was 7 years old. We captured significant curling injuries during seven months of the year. From the secondary survey, we obtained an average of 2.1 AEs per week (Table 2). We estimate an acute injury rate requiring ED presentation at 0.17 per 1000 AEs (95% CI: 0.12–0.22).

TABLE 3
Demographic characteristics of curlers presenting to emergency departments with an acute injury, 1993–2011

Age, years	Male	Female	Total
0–17	6	7	13
18–34	15	23	38
35–49	19	23	42
50–64	21	36	57
≥65	37	21	58
Total	98	110	208

Injury characterization

Table 4 presents a detailed listing of all injuries. Of the acute injuries, 92.7% were the result of falls on ice. There were two stereotypical patterns of falls: slipping backwards, resulting in an occipital head injury (28.1%), or slipping forwards, resulting in a Fall On Outstretched Hand (FOOSH) injury (20.8%). Together, these mechanisms accounted for 49.0% of falls.

Consistent with these mechanisms, the most common category for injuries following falls were head injuries, followed by wrist/hand injuries; together, they tallied 54.3% of the total of acute injuries (Figure 1). Head impact injuries included 37 closed head injuries/concussions (Table 4), and 19.3% of injuries from falls.

Attitudes towards injury prevention strategies

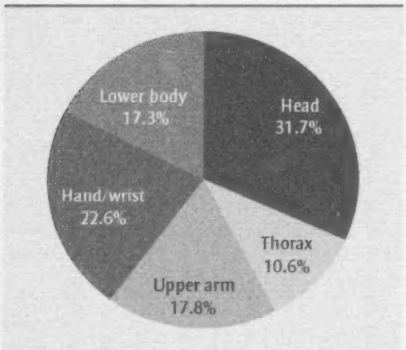
Of the 104 mail surveys 13 were returned unopened. Of the 91 individuals who we presume received the survey, 49 returned completed surveys (54%). The responding population did not differ significantly from the overall population by gender or age grouping ($p > .05$).

Many of the injured were practised curlers; the majority (54%) had at least

TABLE 4
List of acute curling injuries by anatomical grouping

Site of injury	Description	Number of injuries documented	%
Head			
Brain	Closed head injury/concussion	37	17.8
	Nerve injury	1	0.5
	Intracranial bleed	3	1.4
Skull	Soft tissue injury	12	5.8
Face	Soft tissue injury	13	6.3
Trunk			
Thorax	Soft tissue injury	9	4.3
	Fracture	8	3.8
Lower Back	Soft tissue injury	5	2.4
Upper arm			
Shoulder	Soft tissue injury	13	6.3
	Dislocation/fracture	9	4.3
Elbow	Soft tissue injury	10	4.8
	Fracture	5	2.4
Wrist/hand			
Wrist	Soft tissue injury	11	5.3
	Fracture	23	11.1
Hand	Soft tissue injury	8	3.8
	Dislocation/fracture	5	2.4
Lower body			
Hip	Soft tissue injury	3	1.5
	Fracture	5	2.4
Knee	Soft tissue injury	9	4.3
	Dislocation/fracture	5	2.4
Lower leg	Fracture	3	1.4
Ankle/foot	Soft tissue injury	7	3.4
	Fracture	4	1.9
Total		208	100.0

FIGURE 1
Anatomical location of acute curling injury, divided by grouping



7 years of curling experience and curled between 1 and 4 times a week during the season (74%) (Table 3).

As suggested by the results from the full data set, survey respondents attributed over 90% of their injuries to falls on the ice, most commonly due to the lack of proper curling footwear. 41.3% of survey respondents attributed their fall to a lack of proper footwear. Mandating use of proper footwear received support from nearly three-quarters of respondents (Table 5).

One survey question asked what participants thought about using helmets while curling. Whereas few respondents (8%) thought helmets should be mandatory, 85% of respondents either believed in a use for helmets under certain circumstances (e.g. for learners, young children, curlers with disabilities) or that they should be recommended for general use (Table 5).

TABLE 5
Attitudes of secondary survey respondents towards curling injury prevention strategies

	Helmet wear, % (n=48)	Curling-specific footwear, % (n=49)
Use unnecessary	6	0
Use under certain circumstances	50	8
Use generally, recommended	35	18
Use mandatory	8	74

The surveyed curlers did not significantly support the use of wrist guards, such as those used in snowboarding.

Though anecdotally associated with curling, we did not find alcohol use to contribute significantly to acute injury. Only one respondent believed that alcohol contributed to injury. Similarly, only 3 CHIRPP database and medical records documented alcohol as a factor.

Discussion

Our retrospective case series found that injuries in the recreational curling population were principally the result of falls, either through falling forward in such a way that resulted in a wrist injury or falling backwards, resulting in a head injury. We also found that injuries experienced by curlers can be serious and, most disconcertingly, involve brain injury. The rate of acute injury requiring ED presentation in the recreational population was 0.17 per 1000 AEs. The culture of curling at the recreational level does not rigidly enforce proper curling footwear, the lack of which curlers identified as a primary cause of falls.

About one-third of falls resulted in head injuries. Head injuries were not specifically reported in the literature on competitive curling, suggesting that this risk is higher within the recreational curling population. This would be logical, as recreational curlers, especially beginners, are less comfortable with sliding on the ice and at higher risk of uncontrolled falls. Similarly, backwards falls onto the head have been observed more frequently among beginner snowboarders compared to their seasoned peers.[13]

Recently, the scientific community has increased its attention towards the sequelae of sport-related concussions.[14-15] The effectiveness of various means of head protection, however, remains unclear. Whereas helmets do reduce the risk of moderate to severe head injuries, current helmet designs may not prevent concussion.[16-18] Furthermore, although our survey found that most curlers believe in a role for helmets, actual use is rare and stigmatized. Faced with similar challenges, other sports have implemented changes to rules to reduce concussions.[13] In curling, this approach could include mandating use of curling footwear, which improves control on the ice and thus may prevent falls and resultant head injuries altogether. As nearly half of our survey respondents attributed their fall to a lack of proper footwear, curling clubs should have little difficulty mandating the use of appropriate footwear and/or making it available on site.

In Kingston, one curling club has a policy that requires curlers aged 11 and under to use helmets. In our dataset, 8 injured athletes were younger than 11. The literature suggests that the concussed pediatric athlete has a longer recovery time and different physiological response compared to older athletes.[19-21] Other research suggests that females may also be at higher risk of concussion and have slower recovery times.[22-24] Therefore, more aggressive prevention strategies may be indicated in these groups as well as among adult beginners.

Strengths and limitations

While our study identified a relatively small number of curling injuries, which permitted only a descriptive analysis, it is the most complete examination of acute curling injuries to date and is the first to describe injuries experienced by recreational curlers. We used an established injury surveillance program for ED-based care that identifies all injured people presenting to one of two settings serving a geographically distinct population. Given the low rate of injury occurrence, a prospective study design was less feasible. We also performed a secondary survey to enhance data available from CHIRPP and to ask for opinions related to injury prevention strategies. We identified head injury as making up a significant portion of acute curling injuries and, based on the survey responses, have identified a simple prevention strategy—mandated curling footwear use.

However, our results stem from a retrospective case series design and an approximation of the population at risk. Our injury estimates are likely conservative as

we tracked only those people with injuries who sought care in an ED setting.

Our secondary survey was completed by only 54% of those receiving the survey. This small sample size was used to estimate AEs for recreational curlers. Further, although the gender and age profiles of survey respondents did match the overall Kingston curling population, all the curlers surveyed had been injured—meaning that they might be more likely to support safety measures compared to those who have not been injured. Nevertheless, all survey respondents agreed with the use of some level of proper footwear while curling, and nearly three-fourths thought it should be mandated, suggesting that the attitude of the general curling population would be in favour of regulation.

Conclusion

Our study, based on a well-established injury surveillance program (CHIRRP), is the first to present information on injury occurrence and typology in recreational curlers. Most injuries occur by falling, with lack of proper curling footwear being reported as a key contributor.

We recommend that proper curling footwear be mandated and that curling clubs review their head protection policies, particularly among beginners and young curlers. For the ED clinician, the curling-related visit may present an opportunity to encourage players to use proper footwear to prevent future injury.

Future studies could further examine relationships between curling expertise and injury to better define the circumstances under which footwear and helmets would have the most benefit. A survey to assess attitudes of all curlers towards equipment-based strategies could also better characterize athlete opinion.

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Status Report

Retracing the history of the early development of national chronic disease surveillance in Canada and the major role of the Laboratory Centre for Disease Control (LCDC) from 1972 to 2000

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Introduction

Health surveillance is the ongoing, systematic use of routinely collected health data to guide public health action in a timely fashion.[1]

This paper describes the creation and growth of national surveillance systems in Canada and their impact on chronic disease and injury prevention.

In 2008, the authors started a review process to retrace the history of the early development of national chronic disease surveillance in Canada from 1960 to 2000. A 1967 publication describes the history of the development of the Laboratory of Hygiene from 1921 to 1967.[2] This review is a sequel to that paper and describes the history of the development of national chronic disease surveillance in Canada before and after the formation of the Laboratory Centre for Disease Control (LCDC).

A brief history of the structure of federal departments and agencies responsible for chronic disease surveillance in Canada

The 1867 *British North America Act*[3] specified that the census and statistics are the responsibility of the federal government (Table 1). The first national census under the auspices of this act was conducted in 1871.

The 1918 federal *Statistics Act*[4] created the Dominion Bureau of Statistics (DBS, called Statistics Canada as of 1971) with a mandate to collect and publish statistical information.

The 1919 *Department of Health Act* created the Department of Health.[5] In 1937, the Epidemiology Division was formed in what was then the Department of Pensions and National Health, but was dissolved during World War II, and re-established in 1947 with a focus on infectious diseases. When the Health Protection Branch (HPB) was created within the Department of National Health and Welfare (DNHW) in 1972, the Epidemiology Division was renamed the Bureau of Epidemiology and merged with the much larger Canadian Communicable Disease Centre (formerly called the Division of Laboratories and Medical Research, established in 1921, and renamed the Laboratory of Hygiene in 1925)[2] to form the new the Laboratory Centre for Disease Control (LCDC). In 1972–1973, LCDC's Bureau of Epidemiology initiated the surveillance of cancer and cardiovascular diseases. Surveillance activities for cancer used provincial cancer registry data, while those for cardiovascular disease relied on survey

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TABLE 1
History timeline in national chronic disease surveillance in Canada, 1867–2004

Year	Event
1867	*British North America Act*[3] specified that the census and statistics are the responsibility of the federal government.
1871	The first national census was conducted in Canada under the auspices of the *British North America Act*.
1918	The *Statistics Act*[4] created the Dominion Bureau of Statistics (DBS) (1918–1971) with a mandate to collect and publish statistical information relative to the social, economic and general activities and conditions of the population.
1919	*Department of Health Act* created the Department of Health (1919–1928).[5]
1921	Division of Laboratories and Medical Research (DLMR) (1921-1925) was created in the Department of Health as a national laboratory for public health and research.[2]
1925	DLMR was renamed Laboratory of Hygiene (1925–1971).[2]
1928	The Department of Health was renamed Department of Pensions and National Health (DPNH) (1928–1944).
1937	Epidemiology Division was formed but was dissolved during World War II.
1944	Department of National Health and Welfare (DNHW) was created (1944–1993).[51] DNHW was also referred to as Health and Welfare Canada (HWC) (1980–1993).
1945	The Rockefeller Foundation was commissioned to assess the need for epidemiology services in Canada.
1947–1971	The Epidemiology Division was re-established (1937–1939, 1947–1971) with a focus on infectious diseases.
1954–1961	Large cohort study of Canadian veterans and smoking.[54,55]
1959	Publication of an article by Newcombe et al.[38] described automatic linkage of vital records and stated that computers could be used to follow up individuals and families using files of routine vital statistics and health records. This included the British Columbia registry of handicapping conditions dating back to 1952, a surveillance scheme for congenital anomalies in British Columbia, and the later Registry of Handicapped Children and Adults, which removed the age limit of 21 following the thalidomide disaster in 1961.
1961	Thalidomide was marketed in Canada to treat nausea in early pregnancy. It was the cause of 115 known cases of severe birth defects.
1961	Royal Commission on Health Services (the Hall Commission) recommended that the Dominion Bureau of Statistics (DBS) collect and publish national morbidity statistics. To produce comparable statistics at a national level, DBS created the Hospital Morbidity program.
1965	DNHW established the Voluntary Drug Adverse Reaction Reporting Program (VDARRP).
1966	Maternal Child Health Program initiated a pilot birth-defect surveillance system in 4 provinces.
1970	Congenital Anomalies Surveillance System (CASS) was created, based on the success of a birth-defect surveillance pilot project.
1971	Dominion Bureau of Statistics was renamed Statistics Canada (1971–).
1971	Laboratory of Hygiene was renamed Canadian Communicable Disease Centre (CCDC) (1971).
1972	Epidemiology Division was renamed Bureau of Epidemiology (1972–1986) and merged with CCDC to become the Laboratory Centre for Disease Control (LCDC) (1972–2000).
1972	Health Protection Branch (HPB) (1972–2000) was created with 6 organizational units: LCDC, Foods Directorate, Drugs Directorate, Environmental Health Directorate, Field Operations Directorate and Administration Services.
1972	LCDC and Statistics Canada started to develop data infrastructure to monitor national chronic disease incidence and mortality. Examples include the Canadian Mortality Data Base (CMDB) (data from 1950 onward), a national cancer registry and a generalized record linkage system.
1972	National Cancer Incidence Reporting System (NCIRS), which includes the Canadian Cancer Data Base (CCDB; data from 1969 onward), was established.
1972–1973	LCDC initiated surveillance of cancer and cardiovascular disease.
1973	CASS was transferred from Environmental Health Directorate to LCDC.
1976	Royal Commission on the Health and Safety of Workers and Mines (the Ham Commission) published its report in response to a wildcat strike by mine workers in Elliott Lake over health and safety concerns.
1978–1979	Statistics Canada conducted Canada Health Survey (CHS).
1979	First record linkage workshop held at Statistics Canada devoted almost exclusively to applications in cancer epidemiology.
1980	LCDC initiated a journal, *Chronic Diseases in Canada* (CDIC) (1980–2011). The journal was renamed *Chronic Diseases and Injuries in Canada* (CDIC) in 2011 and *Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice* (HPCDP) in 2015.
1981	Howe and Lindsay[40] describe the Generalized Iterative Record Linkage System (GIRLS), a Canadian invention that is now used worldwide.
1981–1986	Statistics Canada operated the Canadian Renal Failure Registry with joint funding through Health and Welfare Canada (HWC), Statistics Canada and the Kidney Foundation of Canada.
1984	*Canada Health Act*[56] was adopted. The Act specifies the conditions and criteria with which the provincial and territorial health insurance programs must conform to receive federal health transfer payments. These criteria require universal coverage (for all "insured persons") for all "medically necessary" hospital and physician services, without co-payments.

Continued on the following page

TABLE 1 (continued)
History timeline in national chronic disease surveillance in Canada, 1867–2004

Year	Event
1984	Recommendations of a Health Protection Branch (HPB) science panel on epidemiology included: (a) surveillance of human health risks related to products regulated by HPB, (b) new data sources, (c) communication and (d) collaboration between personnel and coordination of activities in HPB and in other agencies.
1984	The Bureau of Epidemiology initiated plans for Nova Scotia–Saskatchewan Cardiovascular Disease Mortality Study (NSSCDMS), including validation of hospitalization data on myocardial infarctions.
1985	National diabetes task force meeting in Montebello, Quebec, recommended developing and implementing a national program to combat diabetes.
1985–1988	LCDC led the Community Risk Factor Survey to assess risk factor prevalence at the local level.
1985–1989	LCDC conducted the LCDC/National Health Research and Development Program (NHRDP) Epidemiology Graduate Student Training Program.
1986	Bureau of Epidemiology was split into the Bureau of Communicable Disease Epidemiology and the Bureau of Non-communicable Disease Epidemiology (BNDE) (1986).
1986	The first provincial heart health survey, under the Canadian Heart Health Initiative (CHHI) of the Health Promotion Directorate, was conducted in Nova Scotia. Eventually all 10 provinces undertook heart health surveys between 1986 and 1995.
1987	BNDE was renamed the Bureau of Chronic Disease Epidemiology (BCDE) (1987–1995).
1987	BCDE initiated surveillance of asthma morbidity and mortality using Statistics Canada national databases. This report[17] led to a national workshop on asthma that recommended carrying out descriptive, case-control and cohort studies. Subsequently, several studies were conducted.[57-59]
1987	Canadian Renal Failure Registry was incorporated into the Canadian Organ Replacement Registry and run by Hospital Medical Records Institute (HMRI). It was funded as a partnership of the federal and provincial governments.
1987	BCDE organized a national workshop on Alzheimer disease that strongly recommended a national multi-centre research study.
1989	Statistics Canada initiates its journal *Health Reports* (HR) (1989–).
1989	Statistics Canada initiates development of the Canadian Cancer Registry (CCR) (1992–).
1989	BCDE collaborated with the Canadian Pediatrics Society to initiate the Children's Hospitals Injury Research and Prevention Program (CHIRPP) (1989–, renamed Canadian Hospitals Injury Reporting and Prevention Program in 1991) for the surveillance of childhood injuries.
1989	The first Canadian Epidemiology Research Conference and record linkage workshop were held. Follow-up from these meetings led to the establishment of the Canadian Society for Epidemiology and Biostatistics (CSEB) in 1990.
1989	BCDE collaborated with the University of Ottawa to initiate the Canadian Study of Health and Aging (CSHA), which had 3 study phases of data collection (1991–1992, 1996–1997, 2001–2002).
1990	BCDE initiated active surveillance of childhood cancers, asthma, diabetes, child maltreatment and perinatal health.
1990	Mortality study of Canadian male farm operators[60] was the first cohort study of cancer risks in relation to pesticide use among farmers and also the first epidemiologic study based on linkage of general population and agricultural census records.
1991	Health Canada published first report on Economic Burden of Illness in Canada (EBIC) with 1986 data.[31] These analyses of direct and indirect costs of illness in Canada included estimates for major disease categories and injuries.
1992	Canadian Cancer Registry (CCR) was established (1992–).
1992	Proposal to develop a childhood cancer control program was submitted and accepted under the federal Brighter Futures initiative. Funds started in 1994, as did registration in the national database of the Canadian Childhood Cancer Control Program (CCCCP).[13]
1992–1994	The Cancer Bureau contracted University of Toronto and the Ontario Cancer Treatment and Research Foundation (OCTRF) to conduct the Great Lakes Basin Cancer Risk Assessment Study (GLBCRAS).[14,15]
1993	DNHW was restructured, and the health component was renamed Health Canada (1993–).
1993	Development of the Canadian Birth Data Base (CBDB) and Canadian Stillbirth Data Base (CSDB) (data from 1985) was initiated to study reproductive outcomes using record linkages.
1993	An asthma program was established in BCDE as a separate division because of observed increases of hospitalization and mortality rates due to asthma among young Canadians.
1993	Canadian Breast Cancer Screening Data Base (CBCSD) was established by BCDE to monitor and evaluate organized breast cancer screening programs.
1994	The Canadian Institute for Health Information (CIHI) (1994–) was established to provide essential information on Canada's health system and the health of Canadians. Responsibility for hospital separation data was transferred from Statistics Canada to CIHI.
1994	Statistics Canada started the National Population Health Survey (NPHS) (1994–).
1994–1995	LCDC identified perinatal health as a priority health surveillance gap.
1994–1997	National Enhanced Cancer Surveillance System (NECSS) was conducted through federal–provincial collaboration. Detailed risk factor questionnaire information was collected (beginning in 1994) from a Canada-wide sample of patients recently diagnosed with cancer and population control subjects.

Continued on the following page

TABLE 1 (continued)
History timeline in national chronic disease surveillance in Canada, 1867–2004

Year	Event
1995	Creation of 3 chronic disease bureaus within LCDC: (1) Cancer Bureau (CB) (1995–2000), (2) Bureau of Reproductive and Child Health (BRCH) (1995–2000) and (3) Bureau of Cardio-Respiratory Diseases and Diabetes (BCRDD) (1995–2000).[8]
1995	Canadian Perinatal Surveillance System (CPSS) (1995–) was initiated to collect and analyze data on all recognized pregnancies (regardless of their outcome) and on the health of the baby during the first year of life.
1995–1996	The Student Lung Health Survey (SLHS) was a school-based survey of children aged 5–19 years in 9 voluntary health units across Canada.
1995–2000	LCDC led the National Asthma Control Task Force (NACTF) and developed the National Asthma Prevention and Control Strategy.
1996	LCDC officially launched its website to provide public health information online.
1996	National Diabetes Surveillance System (NDSS) was initiated (1996–2009). NDSS expanded and became the Canadian Chronic Disease Surveillance System (CCDSS) in 2009.
1996	Development of a child maltreatment surveillance program began. Canadian Incidence Study of Reported Child Abuse and Neglect (CIS) started collecting data in 1998.
1996–1997	BCRDD conducted the Physician Asthma Management Survey (PAMS) to identify physicians' practices in Canada.
1996–1998	To address the key components of perinatal health, Canadian Perinatal Surveillance System (CPSS) created (1) the Fetal and Infant Health Study Group, (2) the Maternal Health Study Group and (3) the Maternal Experiences Study Group.
1997	Health Canada published second report on Economic Burden of Illness in Canada (EBIC) with 1993 data.[32]
1998	LCDC participated in a steering committee on risk factor surveillance at the local level. In 1999, a pilot project was conducted to test the concept and a prototype of a rapid risk factor surveillance system at the local level.[42] This subsequently led to the Rapid Risk Factor Surveillance System (RRFSS), which has been in operation in Ontario since then.
2000	LCDC was dissolved and reorganized as the Population and Public Health Branch (PPHB) (2000–2004) of Health Canada. The Centre for Chronic Disease Prevention and Control (CCDPC) (2000–2012, renamed Centre for Chronic Disease Prevention, CCDP, in 2012) was created to include the 3 chronic disease bureaus of the former LCDC.
2000	Statistics Canada started the Canadian Community Health Survey (CCHS) (2000–).
2000	First Canadian Perinatal Health Report was published.
2002	Health Canada published online the third report on Economic Burden of Illness in Canada (EBIC) with 1998 data.[11]
2004	PPHB was reorganized and upgraded to a higher level, and the Public Health Agency of Canada (PHAC) (2004–) was established. The work of PHAC covers both chronic and infectious disease surveillance and emergency preparedness. A branch within PHAC, the Health Promotion and Chronic Disease Prevention Branch (HPCDPB) (2004–), was created to oversee chronic diseases, including surveillance.
2004	Chronic Disease Surveillance Division (CDSD) (2004–2010) within the Centre for Chronic Disease Prevention and Control (CCDPC) of the Health Promotion and Chronic Disease Prevention Branch (HPCDPB) specifically plans, co-ordinates and conducts national chronic disease surveillance. It was renamed as the Chronic Disease Surveillance and Monitoring Division (CDSM) in 2010 and the Surveillance and Epidemiology Division (SED) in 2014 (2014–).

and mortality data.[6,7] In 1995, three bureaus were created in LCDC—the Cancer Bureau, the Bureau of Reproductive and Child Health (BRCH) and the Bureau of Cardio-Respiratory Diseases and Diabetes (BCRDD).[8]

In 2000, Health Canada was reorganized, and LCDC was combined with the Health Promotion and Programs Branch (HPPB) to create a new branch, the Population and Public Health Branch (PPHB).[9] In 2004, PPHB was reorganized and became part of the Public Health Agency of Canada (PHAC).

Figure 1 summarizes the organizational evolution of the federal health departments, branches and directorates that relate to the development of national chronic disease surveillance in Canada.

Besides Health Canada and PHAC, two other major organizations that contribute to national chronic disease surveillance are Statistics Canada and Canadian Institute for Health Information (CIHI).

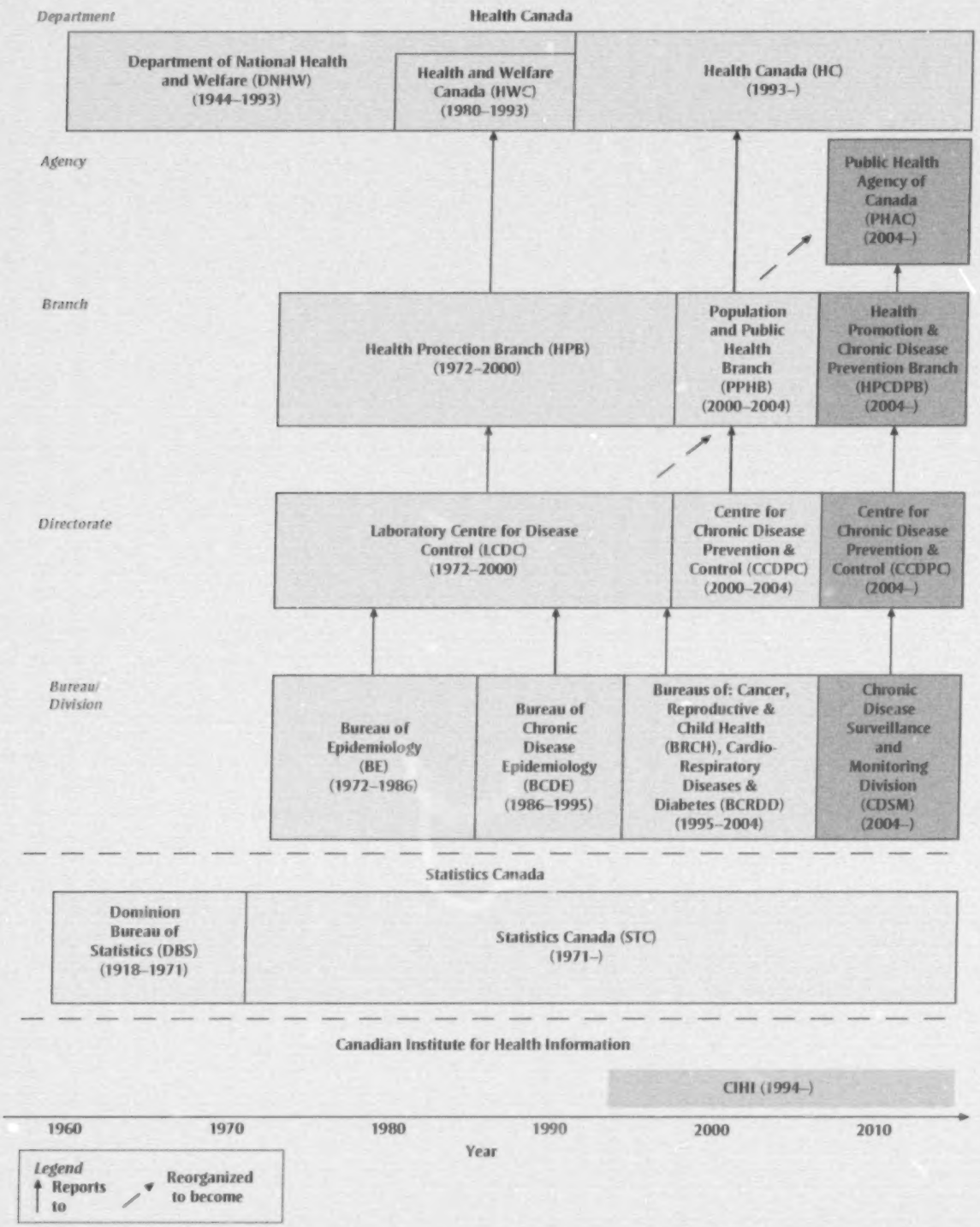
A brief history of major initiatives for chronic disease surveillance in Canada

Cardiovascular disease

The Nova Scotia–Saskatchewan Cardiovascular Disease Mortality Study (NSSCDMS) was a collaborative surveillance project initiated in 1984 by the Bureau of Epidemiology. This study produced the first population-based estimates of acute myocardial infarction incidence, recurrence and survival in Canada.[10] Existing administrative data sets were used for surveillance purposes through record linkage, linking hospital admission/separation records with mortality data, and thus creating person-oriented information for the first time.[11]

Important provincial partnerships with the Canadian Heart Health Initiative (CHHI) (1986–1995) of the Health Promotion Directorate supported standardized risk factor surveys in the provinces, including both behavioural and biological measures, and paved the way for the future work in Canada. In 1986, the first provincial heart health survey was conducted in Nova Scotia. Eventually, all 10 provinces undertook heart health surveys between 1986 and 1995. Through home interviews and clinic visits, the heart health surveys collected information and physical measures on cardiovascular risk factors as

FIGURE 1
Organizational changes in the Canadian federal government departments and agencies that conducted national chronic disease surveillance, 1960–2010


Department
Health Canada
Department of National Health and Welfare (DNHW) (1944–1993)
Health and Welfare Canada (HWC) (1980–1993)
Health Canada (HC) (1993–)
Agency
Public Health Agency of Canada (PHAC) (2004–)
Branch
Health Protection Branch (HPB) (1972–2000)
Population and Public Health Branch (PPHB) (2000–2004)
Health Promotion & Chronic Disease Prevention Branch (HPCDPB) (2004–)
Directorate
Laboratory Centre for Disease Control (LCDC) (1972–2000)
Centre for Chronic Disease Prevention & Control (CCDPC) (2000–2004)
Centre for Chronic Disease Prevention & Control (CCDPC) (2004–)
Bureau/ Division
Bureau of Epidemiology (BE) (1972–1986)
Bureau of Chronic Disease Epidemiology (BCDE) (1986–1995)
Bureaus of: Cancer, Reproductive & Child Health (BRCH), Cardio-Respiratory Diseases & Diabetes (BCRDD) (1995–2004)
Chronic Disease Surveillance and Monitoring Division (CDSM) (2004–)
Statistics Canada
Dominion Bureau of Statistics (DBS) (1918–1971)
Statistics Canada (STC) (1971–)
Canadian Institute for Health Information
CIHI (1994–)
1960
1970
1980
1990
2000
2010
Year
Legend
Reports to
Reorganized to become

well as knowledge of the causes and consequences of cardiovascular disease.[12]

Cancer

The National Cancer Incidence Reporting System (NCIRS) was initiated in 1972 by Statistics Canada in collaboration with the National Cancer Institute of Canada and Health and Welfare Canada. Eventually, data were collected back to 1969 from all of the provincial and territorial cancer registries. In 1974, the Bureau of Epidemiology formed a section to accelerate analysis of national cancer incidence and mortality data. The Canadian Cancer Registry (CCR) was established in 1992. The person-oriented CCR was developed over 10 years from 1988 to 1998, and starting with data from 1992, featured internal record linkage to remove duplicates and death clearance to permit calculation of survival rates. As of 1987, *Canadian Cancer Statistics* provides annual ongoing national surveillance of trends as well as current year estimates of the cancer burden.

In 1992, the Bureau of Chronic Disease Epidemiology (BCDE) initiated the Canadian Childhood Cancer Control Program (CCCCP). BCDE worked with the 21 pediatric oncology centres in Canada to collect childhood cancer data with detailed patient information that allowed for enhanced surveillance and etiological research.[13]

In 1992–1994, the Cancer Bureau participated in the Great Lakes Basin Cancer Risk Assessment Study (GLBCRAS) in collaboration with the Environmental Health Directorate of the Health Protection Branch (HPB) and Environment Canada. The Division contracted the University of Toronto and the Ontario Cancer Treatment and Research Foundation (OCTRF) to study the effect of chlorinated drinking water on the development of bladder and colon cancers.[14,15]

In collaboration with the Health Programs and Services Branch of Health Canada, the BCDE established the Canadian Breast Cancer Screening Database (CBCSD) in 1993 to monitor and evaluate organized breast cancer screening programs.

Between 1994 and 1997, LCDC conducted the National Enhanced Cancer Surveillance System (NECSS) in collaboration with the provincial cancer registries, collecting detailed risk factor information by questionnaire from a Canada-wide sample of over 20 000 patients diagnosed with one of 19 types of cancer and over 5000 population-based control subjects.[16] The Environmental Quality Data Base (EQDB) was developed in parallel to link with the subjects' residential histories and aid research on the relationships between cancer and measures of industrial activity, and air and drinking water quality.

Asthma

In 1987, the Bureau of Chronic Disease Epidemiology (BCDE) began the surveillance of asthma morbidity and mortality using Statistics Canada's national databases.[17] After detecting an epidemic of asthma deaths among Canadians aged 15 to 34 years, BCDE convened a national workshop in 1987 that stimulated research on asthma and highlighted the need for improved asthma treatment. In 1993, an asthma program was established in BCDE.

In 1995, the BCRDD, in partnership with national medical and health professional associations, established the National Asthma Control Task Force (NACTF) to reduce asthma morbidity and mortality in Canada. Between 1995 and 2000 the NACTF developed the National Asthma Prevention and Control Strategy. To collect necessary data for formulation of effective asthma intervention strategies, an asthma supplement survey was incorporated into the National Population Health Survey (NPHS) in 1995.

The Student Lung Health Survey (SLHS; 1995–1996), a school-based survey of children aged 5 to 19 years in nine voluntary health units across Canada, was part of a Sentinel Health Unit Surveillance System.[18] BCRDD conducted the Physician Asthma Management Survey (PAMS; 1996–1997) to identify physicians' practices in Canada.[19,20]

Diabetes

BCRDD initiated the National Diabetes Surveillance System (NDSS) in 1996. The NDSS was the first such system to use provincial data on physician encounters and hospitalizations to calculate disease prevalence. NDSS was a network of regionally distributed diabetes surveillance systems that compiled administrative health care data relating to diabetes and sent aggregate anonymous data to Health Canada for national analyses. In 2009, NDSS expanded into the Canadian Chronic Disease Surveillance System (CCDSS) with the addition of hypertension, asthma and other chronic disease surveillance.

Child and maternal health

The thalidomide disaster in 1961 caused 115 known cases of severe birth defects during 1961 and 1962.[21] As a result, Department of National Health and Welfare (DNHW) established the Voluntary Drug Adverse Reaction Reporting Program (VDARRP) in 1965. In 1966, the Child and Maternal Health Division started a pilot system of birth-defects surveillance in 4 provinces (British Columbia, Alberta, Manitoba and New Brunswick),[22] and in 1966, the Congenital Anomalies Surveillance System (CASS) was established. By 1989, the system included Alberta, Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island and the Northwest Territories, while British Columbia had stopped submitting data.[23] Newfoundland joined in 2004.[24] This was the first national purpose-built surveillance system based on vital statistics data.

In 1989, the BCDE collaborated with the Canadian Pediatrics Society to initiate the Children's Hospitals Injury Research and Prevention Program (CHIRPP). CHIRPP became the Canadian Hospitals Injury Reporting and Prevention Program in 1991. In 1995, the Canadian Perinatal Surveillance System (CPSS) was initiated to collect and analyze data on all recognized pregnancies and on the health of the baby during the first year of life. This is an ongoing national surveillance program, now delivered through PHAC. In 1996, the Bureau of Reproductive and Child Health (BRCH) initiated a child maltreatment surveillance program, the Canadian Incidence Study of Reported Child Abuse and Neglect (CIS), which collects data from all Canadian jurisdictions.[25]

Starting in 1993, Statistics Canada provided the Canadian Birth Data Base (CBDB) and the Canadian Stillbirth Data Base (CSDB) with data from 1985 onward, in response to the ongoing need for the Canadian Perinatal Surveillance System and other uses.[26,27]

Aging-related diseases

In 1989, the BCDE collaborated with the University of Ottawa to initiate 3 phases of the Canadian Study of Health and Aging (CSHA), designed to measure the incidence and prevalence of Alzheimer's disease and other dementias and explore potential causal factors on a national scale.[28] The CSHA operated in 18 centres across all provinces and, in 1991 to 1992, recruited over 10 000 seniors who participated in screening interviews, a risk factor questionnaire, a clinical examination and clinical tests.[29,30]

Cost of illness

The Economic Burden of Illness in Canada (EBIC) is an analysis of the direct and indirect costs of illness in Canada. LCDC published the first EBIC report with 1986 data in 1991,[31] and again with 1993 data in 1997.[32] The 1998 data were published online.[33]

The first EBIC report provides comprehensive and authoritative estimates of the cost of illness in Canada. These estimates are vital to setting priorities for allocating limited health resources. The second report improved significantly on the first, providing estimates of the direct and indirect costs of illness in Canada by age and sex. To research and write the third report, LCDC staff collaborated with their colleagues in Statistics Canada, CIHI and Health Canada to provide information by cost component (direct and indirect), diagnostic category, age, sex and province/territory.[33] The project was moved from LCDC's Cancer Bureau to the Bureau of Policy and Planning, and is now managed by PHAC.

Surveys and administrative databases

National surveying of chronic diseases was in its infancy in Canada when the LCDC was formed in 1972. Early surveys included the Canadian Sickness Survey (1950–1951), the Survey of Smoking Habits (supplements to the Labour Force Survey) (1966–1975) and the Nutrition Canada Survey (1970–1972).[34]

In the 1970s, LCDC and Statistics Canada developed data infrastructure to monitor national chronic disease trends and to facilitate the conduct of major epidemiology (cohort) studies. The computerized Canadian Mortality Data Base (CMDB) was initiated to facilitate record linkage to national death records (from 1950 onwards) for a major cohort study[35] after the National Cancer Institute of Canada provided a small subvention. The NCIRS (from 1969 onward) was used not only for surveillance but also to evaluate screening programs, to conduct cohort studies and, eventually, for survival analysis.[36,37] With the process of record linkage pioneered by Newcombe,[38,39] utilizing these databases was facilitated by the development of a Generalized Iterative Record Linkage System (GIRLS).[40,41]

Since the Canada Health Survey was conducted in 1978 to 1979, more surveys have become available. Examples include the General Social Surveys (1985–), the Health and Activity Limitations Survey (1983–), the Heart Health Surveys (1986–1995), the National Population Health Survey (1994–) and the National Longitudinal Survey of Children and Youth (1995–).[34] The Canadian Community Health Survey (2000–) and the Canadian Health Measures Survey (2007–) are the most recent national health surveys relevant to chronic disease surveillance.

In 1998, LCDC collaborated with Cancer Care Ontario, Ontario Ministry of Health and Durham Regional Health Authority to set up a steering committee on risk factor surveillance at the local level. In 1999, a pilot project was conducted in the Durham health region to test the concept and a prototype of a rapid risk factor surveillance system at the local level. The pilot project, which proved to be a success,[42] subsequently led to the Rapid Risk Factor Surveillance System (RRFSS) still in operation in Ontario today.

Record linkage

A significant achievement in science was the Canadian invention of the world's first protocol for computerized record linkage. Methodological research on computerized record linkages arose out of the necessity to link individuals' records from different databases. The LCDC conducted this research in collaboration with Statistics Canada and the National Cancer Institute of Canada (NCIC) Epidemiology Unit at the University of Toronto.[26,38-40,43-46] In the mid-1970s, the GIRLS was developed to facilitate cohort studies.[40,41] From 1978 to 2000, LCDC funded several occupational and environmental health research projects involving record linkage.[27,47,48]

Although record linkage was initially to assess risk, it has become a valuable tool for surveillance. The NDSS (1996–2009) and the subsequent CCDSS (2009–) rely heavily on record linkage. Computerized record linkage is now widely used across Canada and around the world.

Information dissemination

In 1980, LCDC started a journal, *Chronic Diseases in Canada* (CDIC) (1980–2011), which was renamed *Chronic Diseases and Injuries in Canada* (CDIC) in 2011 and *Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice* in 2015. In 1989, the Health Statistics Division of Statistics Canada initiated its new journal, *Health Reports* (HR) (1989–). Both journals publish peer-reviewed articles on chronic disease epidemiology, public health, biostatistics, behavioural sciences, health services and health economics. Many disease- and topic-specific publications have also been produced by the former LCDC, PHAC, Statistics Canada and CIHI.

In 1996, LCDC officially launched its website to provide public health information online. Moving into the electronic age, the general public has benefited greatly from online information products such as Disease Surveillance On-Line (http://www.phac-aspc.gc.ca/dsol-smed/) and Injury Surveillance On-Line (http://www.phac-aspc.gc.ca/surveillance-eng.php). Since 2000, *Health Indicators* has been

produced jointly by Statistics Canada and CIHI (http://www.cihi.ca/cihiweb/dispPage.jsp?cw_page=indicators_e). An online publication, *Health Indicators* is a compilation of indicators measuring health status, non-medical determinants of health, health-system performance, and community and health-system characteristics.

Discussion

National chronic disease surveillance has a critical role in determining trends in chronic diseases. Surveillance enables governments and stakeholders to monitor the effects of public health interventions and project health resource requirements. The basic question is, what effect has surveillance information and activities had on improving the health of Canadians? Surveillance is only a means to an end. Surveillance is useful only if the results can be applied to reduce morbidity and suffering, save lives and improve the quality of life of the population.

The disease surveillance work in Canada has helped improve a number of health conditions. The decline in lung cancer cases was partly due to the surveillance and epidemiology work on tobacco use that provided the basis for a major push in the tobacco area. Some LCDC scientists were recognized as expert witnesses in court cases on tobacco. Cancer incidence and mortality data were used to prioritize and evaluate cancer control programs, such as screening for breast and colorectal cancer. The British Columbia Health Surveillance Registry was used early on to assess genetic risk,[49,50] and these data have been quoted in several subsequent reports from official international committees concerned with the potential health risks of exposure to ionizing radiation.[51,52] Other examples of impact on policy and programs include reduced mortality in cardiovascular disease, asthma and many forms of cancer, increased use of folic acid in relation to heart disease, and increased supplementation of food in relation to hydrocephalus and spinal bifida. The discovery in the childhood injury surveillance program of unusual occurrences was useful in generating modifications to baby cribs to prevent further accidents.

This article retraces the history of the development of national chronic disease surveillance in Canada from 1960 to 2004. Our aim was to describe the early milestones in the development and operation of national public health surveillance in Canada. We hope that this will lead to an appreciation of the need for surveillance and act as a catalyst for progress.

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